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BUILDING COMMISSIONING

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CASE STUDY

RIVERSIDE SCHOOL DISTRICT — CORRECTING MECHANICAL AND INDOOR AIR QUALITY PROBLEMS



Riverside High School

Following addition of two classroom wings and a new direct digital control system in 1994, Riverside High School began experiencing problems with indoor air quality and mechanical system operation. Similar issues surfaced at Chattaroy Elementary School where classrooms had also been added.

To deal with the problems, Riverside School District decided to retro-commission the mechanical systems and controls serving the classroom wings at both schools. In early 2000 Riverside School District, in conjunction with the Washington State Department of General Administration's building commissioning program, hired Keithly Welsh Associates to perform the retro-commissioning.

The retro-commissioning project evaluated the existing heating, ventilating, and air-conditioning system as well as the controls operation—comparing them to the original design intent—and identified solutions for bringing the systems into compliance.

COMMISSIONING QUICK FACTS

Building Name	Riverside High School and Chattaroy Elementary School
Location	Chattaroy, Washington
Project	Retro-commissioning of classroom wings
Commissioning Scope	Existing heating, ventilating, and air conditioning (HVAC) system; controls operation as compared to original design intent
Size of Commissioned Area	48,000 sq. ft. (this commissioned area represents approximately 40% of the total square footage of the two buildings)
Total Commissioning Cost	\$32,400
Commissioning Cost per Square Foot	\$0.68
First-Year Cost Benefit	\$8,900
Annual Energy Savings	\$6,900 per year

PROJECT PARTNERS

**Washington State
Department of General
Administration**
Roger Wigfield

Riverside School District
Greg Minden and Bert
Denham

**Keithly Welsh Associates,
Inc.**
(Commissioning Agent)
Bryan Welsh

ATS Spokane
(Control contractor support)
Kevin Treend

Gerard & Associates
(Original design engineer)
Tom Gerard

"Through a cooperative and collaborative team effort..., instances were identified where the systems did not conform to the design intent. These issues were systematically corrected through the efforts of the commissioning consultant and the maintenance crew...

"As a result of this effort, the indoor air quality of the facility was improved. The maintenance staff also gained better knowledge of the systems...

"...I personally will not manage a building project in the future without commissioning the facility."

Greg Minden,
Project Manager
Riverside School District

PROJECT SCOPE OF WORK

The primary project objective was to improve indoor air quality (IAQ), while also making any related energy performance improvements. The commissioning agent first reviewed the buildings' operation and maintenance (O&M) history, including interviews with O&M staff. He then performed functional tests on these HVAC components:

- 3 variable air volume (VAV) air handling units (AHU)
- 1 constant volume AHU
- 36 VAV boxes
- 10 reheat coils
- 6 fan coil units
- 4 exhaust fans
- 9 air monitoring stations
- 2 control systems and graphical interface

Calibrations of the air monitoring stations were verified, along with building air pressure and air flows.

ISSUES IDENTIFIED

Through the retro-commissioning process 118 significant issues were identified at the two schools, more than 60% of which involved the control system (installation, graphics, sequence and calibration). Air balance and deferred maintenance made up most of the remaining issues.

These issues resulted in poor temperature control, reduced outside air intake, and negative building pressure, all of which contributed to poor IAQ. Mold in the classroom walls, apparently resulting from water penetrating the window systems, also contributed to IAQ problems. (Note: mold mitigation was handled under a separate project.)

Among the most significant issues identified were:

- VAV AHU relief dampers did not follow the sequence of operations, resulting in inadequate outside air quantities and negative building pressure.
- VAV AHU air monitoring stations were out of calibration, affecting outside air quantities.
- AHU-1 face dampers were closed when there was a call for heating, during which they should be open.
- AHU-1 outside air damper was loose on its shaft and binding at the end of its range, with outside air quantity varying from too much to too little.
- VAV air flow sensors in one area were out of calibration or defective.

- Heating valves leaked hot water past with no call for heat.
- Exhaust fan in classroom was running at only 20% of design.
- 7 rooms had air supply of 20-50% below design air flow.
- Incorrect and incomplete graphical user interface.

ENERGY IMPLICATIONS OF COMMISSIONING

The primary objective of the retro-commissioning project was to improve air quality. Upon completion of this work, energy consumption for the facilities *increased*—largely because air handling systems had not previously provided enough outside air to maintain IAQ.

However, if IAQ had been fixed without taking energy into consideration, energy usage could have been even higher—thus savings are estimated at \$6,900 annually. Retro-commissioning found solutions to several energy inefficiencies, including:

- The original sequence of operations called for occupancy sensors to be tied into the HVAC system, reducing fan energy use when rooms were unoccupied. However, this feature was not connected during original construction.
- The relief damper sequence for the three VAV AHUs did not function correctly, limiting the amount of air that could be exhausted and restricting energy savings available with the economizer function.
- AHU-4 discharge air temperature swung wildly, creating simultaneous heating and cooling at times.
- Inappropriate control schedules caused AHUs to operate unnecessarily during unoccupied times.
- Outside air sensor location was exposed to solar gain (increasing the sensed temperature by 15 degrees), locking out the economizer prematurely when cool air was actually available.

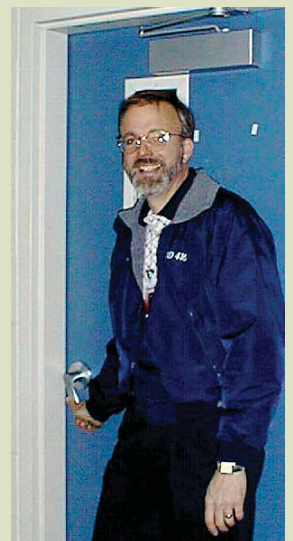
ADDITIONAL BENEFITS

The primary goal of this project—to improve indoor air quality—was achieved. An additional benefit to occupants is improved thermal comfort.

The school district maintenance department played key roles during the project—providing background information, supporting functional testing activities, and performing repairs—which improved their familiarity and expertise with the systems. The final retro-commissioning report provides the maintenance staff with on-going procedures for identifying problems in the field and reproducing tests performed on mechanical systems and controls.

PROJECT BENEFITS

- \$8,900 in first-year cost benefits (such as improved indoor air quality, improved occupant comfort, etc.)
- \$6,900 in annual energy savings
- Maintenance staff increased its familiarity with building systems and controls
- Written document provides procedures for identifying problems in the field and reproducing tests performed on mechanical systems and controls



Greg Minden,
Project Manager
Riverside School District



Chattaroy Elementary School

FOR INFORMATION ON WASHINGTON'S COMMISSIONING PROGRAM



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WHAT IS COMMISSIONING?

Building commissioning is a systematic and documented process of ensuring that building systems perform according to the design intent and the owner's operational needs.

Commissioning is used in both new construction and existing buildings.

Commissioning:

- Provides a better environment for occupants
- Reduces indoor air quality problems
- Reduces occupant complaints
- Reduces contractor call-backs and warranty issues
- Reduces energy consumption and operational costs

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